New Mexico Environment Department
Surface Water Quality Bureau

Keyline Design for Restoration of Headwater Slope Wetlands in the Holman Creek Wetlands Complex Watershed, New Mexico
CD #01F10901-0C
Quality Assurance Project Plan

Submitted to:
U.S. Environmental Protection Agency
Region 6

Submitted by:
New Mexico Environment Department
Surface Water Quality Bureau
1190 Saint Francis Drive
Santa Fe, NM 87502

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APPROVAL SHEET

Project Title: Keyline Design for Restoration of Headwater Slope Wetlands in the Holman Creek Wetlands Complex Watershed, New Mexico, CD #01F10901-0C

Approvals: **New Mexico Environment Department Surface Water Quality Bureau**

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ACRONYMS

CNF	Carson National Forest
EPA	United States Environmental Protection Agency
NMED	New Mexico Environment Department
QA	Quality Assurance
QC	Quality Control
QAPP	Quality Assurance Project Plan
SOP	Standard Operating Procedures
SWQB	New Mexico Environment Department Surface Water Quality Bureau
USFS	United States Forest Service

1.0 PROJECT MANAGEMENT

1.1 DISTRIBUTION LIST

The Project Officer will distribute copies of this approved Quality Assurance Project Plan (QAPP) and any subsequent revisions to the project personnel listed below in Table 1. Upon receipt of the QAPP, those on the list will sign the receiving form (see 6.1) and return to the Project Officer. Receiving forms will be kept on file at SWQB.

New Mexico Environment Department Surface Water Quality Bureau

Wetlands Program Coordinator: Maryann McGraw, maryann.mcgraw@state.nm.us Project Officer/File Manager: Emile Sawyer, Emile.Sawyer@state.nm.us QA Officer: Miguel Montoya, Miguel.Montoya@state.nm.us

The Quivira Coalition

Comanche Creek Program Coordinator: Mollie Walton, Ph.D., mwalton@quiviracoalition.org

USFS, Carson National Forest, Questa Ranger District

Greg Miller Soil Scientist Watershed Program Manager: gregory.miller@usda.gov
John Littlefield Forest Hydrologist: john.littlefield@usda.gov

U.S. Environmental Protection Agency Region 6

State and Tribal Programs Section Chief: Nelly Smith, smith.nelly@epa.gov
Project Officer: Leslie C. Rauscher, Water Quality Protection Division,Rauscher.Leslie@epa.gov

Private Consultants

Restoration Subcontractor:	Jan-Willem Jansens, Ecotone Landscape Planning, LLC jwjansens@gmail.com
Jeff Adams, Terrasophia LLC	jeffrey@terrasophia.com

1.2 PROJECT/TASK ORGANIZATION

This section lists the roles and responsibilities of persons that will collect and/or use the information gathered for the restoration project. A project organizational chart on page 8 – Figure 1, displays hierarchy of project authority and responsibility.

Table 1 Project Roles and Responsibilities

Name	Organization	Role	Responsibilities	Contact Information
Emile Sawyer	SWQB	Project Officer	Manage progress of project, process invoices, lead data collection activities, act as liaison between cooperators, maintains project files, prepares final project report etc.	(505) 827-2827 Emile.Sawyer@state.nm.us
Maryann McGraw	SWQB	Wetlands Program Coordinator	Assist in data collection, training and report preparation; supervise Project Officer	(505) 827-0581 maryann.mcgraw@state.nm.us
Abe Franklin	SWQB	Non-Point Source Program Manager	Reviewing and approving QAPP	(505) 827-2981 abe.franklin@state.nm.us
Miguel Montoya, QA Officer	SWQB	QA Officer	Reviewing and approving QAPP, QA audits, as needed, to assure adherence to the approved QAPP	505-476-3794 Miguel.Montoya@state.nm.us
Mollie Walton	The Quivira Coalition	Comanche Creek Program Coordinator	Project Contractor/ implementation of project	254-688-0348 mwalton@quiviracoalition.org
Gregory Miller	USFS, Carson National Forest	Soil Scientist Watershed Program Manager	Cooperator, assists with project implementation	575-758-6200 x6251 gregory.miller@usda.gov
John Littlefield	USFS, Carson National Forest	Forest Hydrologist	Cooperator, assists with project implementation	(575) 758-6311 john.littlefield@usda.gov
Jan-Willem Jansens	Ecotone Landscape Planning	Restoration Subcontractor	Project implementation	(505) 470-2531 jwjansens@gmail.com
Jeffrey Adams	Terrasophia	Restoration Subcontractor	Project implementation	(415) 306-6618 jeffrey@terrasophia.com
Leslie Rauscher	U.S. EPA	EPA Project Officer	QAPP review and approval	(214) 665-27792773 Rauscher.Leslie@epa.gov

Nelly Smith	U.S. EPA	EPA Management	QAPP review and approval	(214) 665-7109 Smith.Nelly@epa.gov

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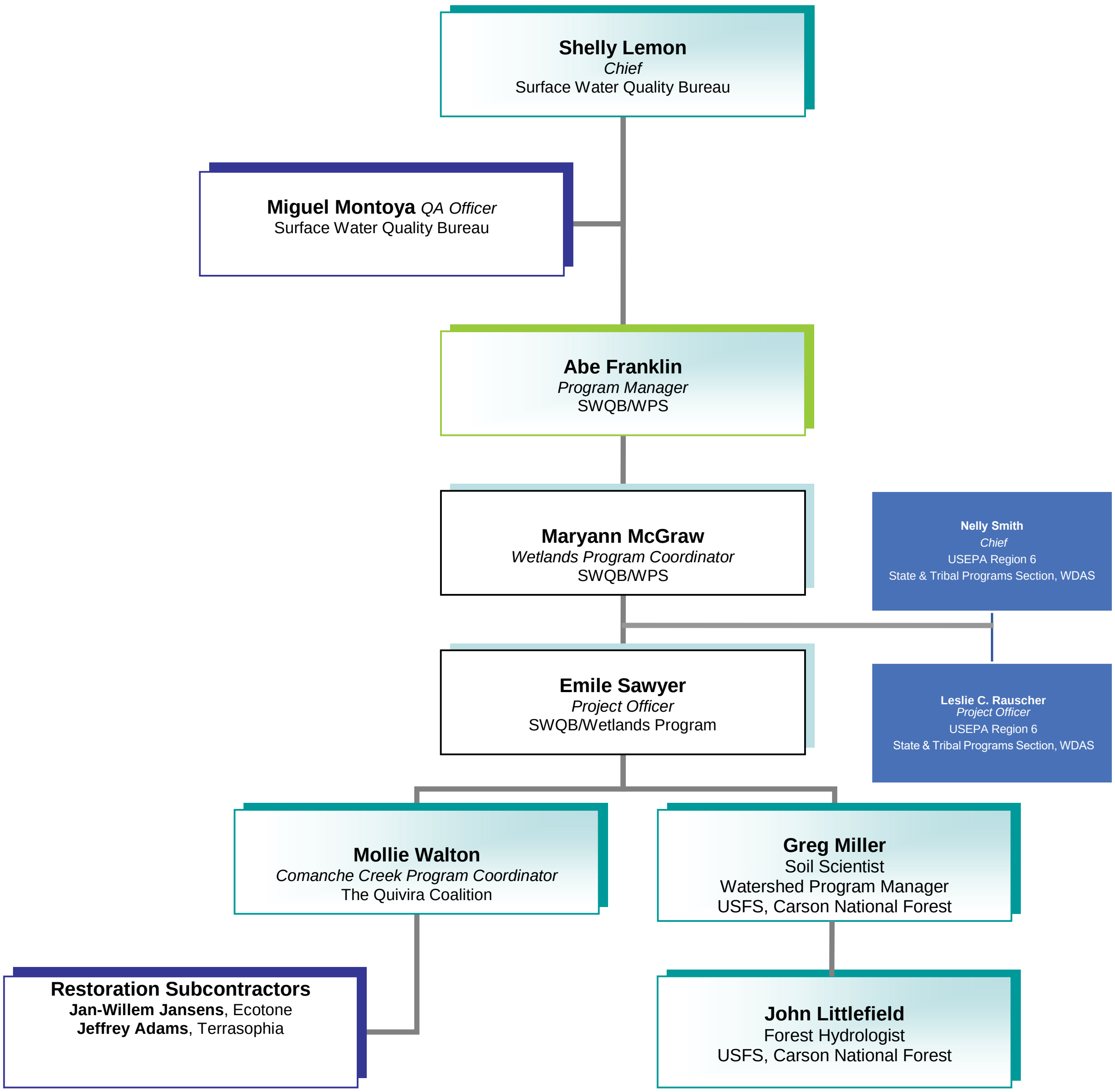
1.3 LINE OF AUTHORITY DESCRIPTION

The organizational structure for this project is presented in Figure 1 below.

Figure 1. Organizational Chart



1.4 PROBLEM DEFINITION/BACKGROUND

The SWQB Wetlands Program protects and restores New Mexico's remaining wetlands and riparian areas with the goal of increasing wetland acreage in New Mexico. The Program identifies impaired wetlands and implements restoration projects funded by U.S. Environmental Protection Agency Wetland Program Development Grants issued under the Clean Water Act Section 104(b)(3). The purpose of the *Keyline Design for Restoration of Headwater Slope Wetlands in the Holman Creek Wetlands Complex* Project is to survey, restore, and increase at least forty acres of degraded slope wetlands in the Holman Creek sub-watershed of the Comanche Creek Watershed, entirely within the Valle Vidal unit of the Carson National Forest (CNF) in Taos County, New Mexico.

This QAPP is a companion document to the Bureau QAPP (*Surface Water Quality Bureau Quality Assurance Project Plan for Water Quality Management Program,* NMED/SWQB 2016 or most current version). The Bureau's Standard Operating Procedures are incorporated in the Bureau QAPP by reference and all relevant policies and procedures specified in the Bureau QAPP will be followed for this project. Any additional procedures unique to the project will be included in this QAPP.

When changes affect the scope, implementation or assessment of the outcome, this QAPP will be revised to keep project information current. The Wetlands Program Coordinator, with the assistance of the QA Officer, will determine the impact of any changes to the technical and quality objectives of the project. This QAPP will be reviewed annually by the Wetlands Project Officer to determine the need for revision.

The Comanche Watershed has been the stage for environmental restoration for nearly 20 years. Comanche Creek, located in the Valle Vidal Unit of the Carson National Forest, is typical of many areas that have experienced exploitive historical use of the landscape, including clear-cut timber harvesting, livestock grazing, and mineral extraction. These activities resulted in the creation of numerous inadequately constructed and maintained roads, overgrazed grasslands, depleted vegetation in riparian zones, unprotected stream banks and headcuts throughout the watershed. The results of these land use practices have led to increased erosion of the land that has amplified the fine sediment load within the watershed, specifically along Comanche Creek. Comanche Creek, a high-quality cold water fishery (NMGF, 2010) that is also home to the Rio Grande Cutthroat Trout (a Species of Concern), was listed for temperature and sediment on the 2006 303(d) list of impaired waters. These bottom deposits and high temperatures negatively affect habitat for fish and other aquatic life. Comanche Creek was delisted for sediment in 2008 (NMED, 2013) due to restoration efforts. Past restoration practices include mini-exclosures along streambanks to promote riparian recovery, in-stream structures to stabilize eroding banks. More recently, the creation of deep pools and meanders, road improvements and closures to decrease sediment input, and improved grazing management practices to restore grasslands have been implemented. These practices are improving the condition of the Comanche Watershed, and wetland conditions are improving as a result. These results have been documented in the recent *Innovative Design and Restoration of Slope Wetlands in the Comanche Watershed Project* and the Section 319 Nonpoint Source Program Success Story (NMED, 2013). The upper reaches where slope wetlands occur are still degrading from headcuts and gullies, sedimentation and channelization. Appropriate restoration measures and designs that restore the distinct features of slope wetlands are needed to improve the important upper reaches of Comanche Creek Watershed that are typified by slope wetlands. This information is being passed on to practitioners and the public to give more recognition and attention to this important wetland type via the recently published "Plug and Pond" technical guide (NMED, 2017).

Keyline design is a set of planning tools developed in a semi-arid region to efficiently distribute water and increase productivity in an agricultural landscape. Keyline design principles and techniques include valley-wide planning and design that places landscape features into categories and prioritizes them to help optimize water redistribution across a project area; water harvesting from channels and ponds to spread water onto dry slopes that improve water efficiency and increase land productivity; and the use of gravity, a topographic hierarchy of land features to aid the designation of water spreading structure locations that promote the rewetting of dry areas. Particularly useful in an undulating topographic setting, a "scale of permanence" is used to inform site design and planning that prioritizes climate, then topography, water supply, roads and access, trees, structures, fencing and soils in that order. Through this planning, ridges, valleys and water courses are identified to inform the process of locating water storage and channel networks for water distribution. This technique has yet to be tested with the scientific method in regard to wetland restoration (Yeomans, 2008; J. Jansens, 2018. pers. comm., March 19).

The SWQB Wetlands Program will implement a demonstration project to apply Keyline design to the restoration of a minimum of 40 acres of headwater slope wetlands in the Holman Creek wetlands complex. The main objective of the project is to utilize Keyline design principles to increase the quality and quantity of headwater slope wetlands by spreading out runoff and increasing infiltration. The project will include conducting planning and field reconnaissance to support design and installation; performing pre-and post-installation ecological monitoring to document project success; developing the Keyline design and obtaining state and federal environmental clearances; installing the project design structures using machinery and volunteer labor; performing substantial outreach to transfer project results to landowners and land managers. The SWQB intends to share the results of the project so that what is learned from the project can be used in other headwater slope wetlands.

The Quivira Coalition and the US Forest Service are partnering with the New Mexico Environment Department Surface Water Quality Bureau (SWQB) to build on the work of the *Innovative Design and Restoration of Slope Wetlands in the Comanche Watershed* Project by using the developed wetland restoration methods with the innovative method of Keyline design. "Keyline design" is an agricultural land planning approach aimed at increasing the agricultural production potential of the land through sustainable agricultural techniques that deepen the living soil. The Keyline refers to the contour line in a so-called “primary valley” where the steeper, convex upper part of a slope changes into a gentler, concave shape lower down. (Yeomans, 2008). To test this technique as an innovative approach to wetlands restoration, we will be collecting a variety of data to track the efficacy of the techniques we are using in restoring slope wetlands in this watershed.

The overall outcome of this project is to characterize, restore and increase by at least 40 acres, the number of slope wetland acres in the Comanche Creek Watershed. The information obtained as part of the project will be useful to private citizens and resource managers looking for ways to successfully protect and restore slope wetlands in New Mexico. Evaluation of the success of the methods employed as part of this project is therefore a critical component of the project.

1.5 PROJECT/TASK DESCRIPTION

Data collection will be done to determine the effectiveness of the Keyline design techniques by evaluating the change in rewetted wetland acres. Pre-treatment data collection activities will be conducted prior to implementation of the Keyline design and installation of water redistribution structures (design features) on four (4) drainages (Figure 2). Design features include worm ditches, zuni bowls, plug and pond, and plug and spread structures. Two volunteer work weekends will help install Keyline design project structures and educate volunteers. The techniques employed will use local materials, be low maintenance and hands-on. A half-day conference workshop on Keyline design will be presented at the Quivira Coalition’s annual conference and a technical guide will be disseminated to potential users of Keyline design planning. Post treatment monitoring data and collection activities will be used to evaluate the effectiveness of the project. Rewetted wetland acres will be quantitatively determined using the following data measurements:

Vegetation cross-section and greenline composition, as conducted in accordance with *Monitoring the Vegetation Resources in Riparian Areas* (Winward, 2000), will be used to evaluate whether project area vegetation changes are due to increases or decreases of wetland vegetation, and observations of soil moisture content.

In order to understand obligative and facultative wetland progression over time, staff will collect individual plant species composition to supplement the vegetation cross-section and greenline composition surveys with vegetative identification along the transect. Staff expertise and knowledge of plant identification will be used to document flora to Genus and species.

Fluvial geomorphology measurements will be collected before and after implementation of the wetland restoration to evaluate if the wetland responded to the water redistribution structures and to determine if the pattern, profile, and dimension improved. Fluvial geomorphologic data will be collected using procedures documented in this QAPP. Transects will be used to quantify and assess the geomorphic setting of the landscape and stream channel characteristics to evaluate channel or sediment changes over time. As water spreads over the wetland area, it is anticipated that channels will decrease in size or show changes in morphology. These data include the production of longitudinal profiles, channel and valley cross sections.

The mapping and identification of valley types, landscape positions, soils and slope gradients in the project area will assist with implementation of Keyline design techniques and structure locations. GPS will be used to map water redistribution structures; vegetation cross-section and greenline composition, cross-sectional and longitudinal profiles; and wetland treatment areas to assess any increases in wetted acreage. GPS data will be imported into ArcGIS to analyze the increase or decrease in wetland acres as an evaluation of the projects effectiveness.

Wetland restoration efforts are often designed to support the expansion of remnant wetlands into the larger area they historically occupied. Monitoring groundwater elevations in the zone surrounding the initial remnant area will provide a baseline for the restoration of hydrology that will support natural self-sustaining wetland conditions with obvious implications for adaptive management. It will also provide early clues about the "micro-areas" where recolonization of desired species are most likely to thrive. Alluvial groundwater levels will be evaluated by constructing either hand augered or piezometer observation points. In-situ Level TROLL® 500 Data Loggers will be installed in the piezometers to measure and store groundwater level, water pressure and water temperature data. Groundwater elevation, groundwater pressure and groundwater temperature measurements will be plotted in excel to assess any changes that could be correlated with increased rewetted wetland acreage.

Under many circumstances, evaluating change over time by using photographic documentation can give great insight into the relative success of restoration efforts. Photographic documentation can also document how well an entire project site is doing with a couple of overview photo sites. Project objectives include increasing the health and function of the degraded wetlands within the project area. Thus, photo monitoring goals will include demonstrating an increase in native wetland vegetation and a decrease in upland vegetation. Photographic documentation will be used in accordance with *Let the Water Do the Work* (Zeedyk et al, 2009) to document visual changes in vegetation and water distribution on the landscape over time. Changes over time will demonstrate the effectiveness of the Keyline design and various design features such as worm ditches, zuni bowls, plug and pond, and plug and spread structures (Gadzia et al, 2014).

Certain soils are characteristic of wetlands and are an important component of monitoring for wetland restoration. A hydric soil is generally saturated, flooded, or ponded long enough in the growing season to develop anaerobic conditions and favor the establishment of wetland vegetation. Expansion of hydric soil boundaries within the project area will indicate increases in rewetted wetland acreage. Wetland soils will be characterized using methods for the description of soils published by NRCS and USACE (USACE 1987, NRCS 2006 and Schoeneburger et al, 2002) to identify hydric and non-hydric soil boundaries. As available resources permit, soil moisture data will also be collected..

Table 2 Products and Timeline

Task	Start Date	Completion Date	Milestone
1. Project Administration/Reporting	Upon award	Dec 2020	• Procurement for contractor completed December 2017
2. Planning/ Restoration Reconnaissance	May 2018	Mar 2018	• Working Group planning meeting April 2018 • Field reconnaissance done by June 2018
3. QAPP	Feb 2018	May-June 2018	• QAPP approval May-June 2018
4. Monitoring	Jun 2018	April 2021	• Pre-treatment data collected by July-August 2018 • Post-treatment annual monitoring each summer through 2020 • Initiate piezometer location and install on wetland sites through 2021 • Review potential locations for installing piezometers, determine data to be collected from each site, install piezometers and recording equipment, download data and analyze results, prepare report.

5. Restoration Design/ State and Federal Clearances	May 2018	June 2018	• Restoration Design completed June 2018 • NEPA completed March 2018 • CWA 404 permit obtained July 2018
6. Restoration Workshops/Project Restoration Implementation	Aug 2018	Aug 2019	• Restoration implementation August-September 2018 • Workshop 1 August 2018 • Workshop 2 August 2019
6.Project results, final report and training	Jan 2019	Sep 2020	• Project results, final report and technical guide completed September 2020
7. Attend EPA Sponsored Conferences/Training	May 2018	Sep 2020	• Meetings/trainings attended by September 2020

Progress will be tracked through quarterly reports outlining the progress and effectiveness of the project based on data collection activities. A final report on the project including project results and interpretation of baseline and post-installation data will be produced and a technical guide that describes the use and effectiveness of Keyline design for headwater slope wetlands will be distributed to the public.

1.6 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

The purpose of this section is to specify the level of quality needed to make decisions regarding the success of the project. As part of safety and quality assurance at least two persons will be in the field collecting data at all times. Many of tasks associated with this project can only be evaluated anecdotally and the quality of the information used for this assessment will be ensured as indicated in the following data quality categories:

Precision -will be ensured by following the procedures identified in this QAPP and having two monitoring participants present during all data collection activities.

Accuracy - the basis for determining accuracy will be staff's expertise of the survey method for collecting data and ensuring the accuracy of the equipment being used is within the required range of a particular survey

Bias – to reduce the systematic or persistent distortion of any measurement process, bias will be minimized by using professional and experienced staff to collect and analyze data.

Representativeness – pre-treatment data collection sites will be determined by areas anticipated to be most influenced by the implementation of the Keyline design. Post-treatment data collection sites will be at the same location as pre-treatment data collection sites.

Comparability - monitoring locations in reference and restoration implementation sites will be monumented for repeat sampling events to compare pre- and post-treatment data. Methods listed under this QAPP for data collection are standardized and reproducible with the intent to be comparable to other studies

Completeness - surveys and methodologies will be completed in their entirety as identified in this QAPP.

Figure 2. Map of Potential Wetland Restoration Areas

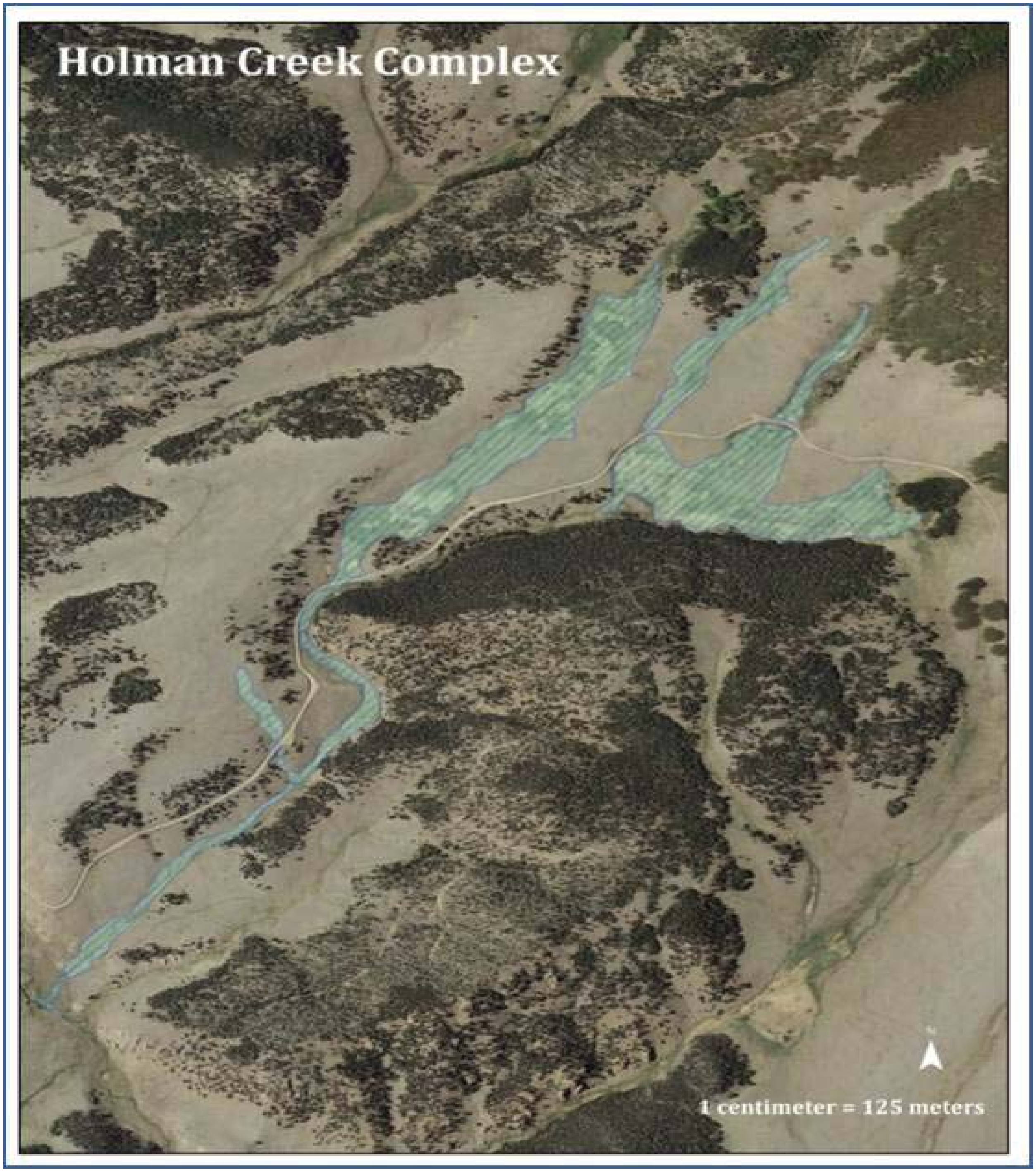


Figure 2. Potential Wetlands restoration areas. Blue shading outlines potential for wetlands restoration in the Holman Creek Wetlands Complex. The SWQB Wetlands Program will use Keyline design to restore a minimum of 40 acres of wetlands within the 106 acre complex.

<u>Figure 3. Map of Comanche Creek Wetlands</u>

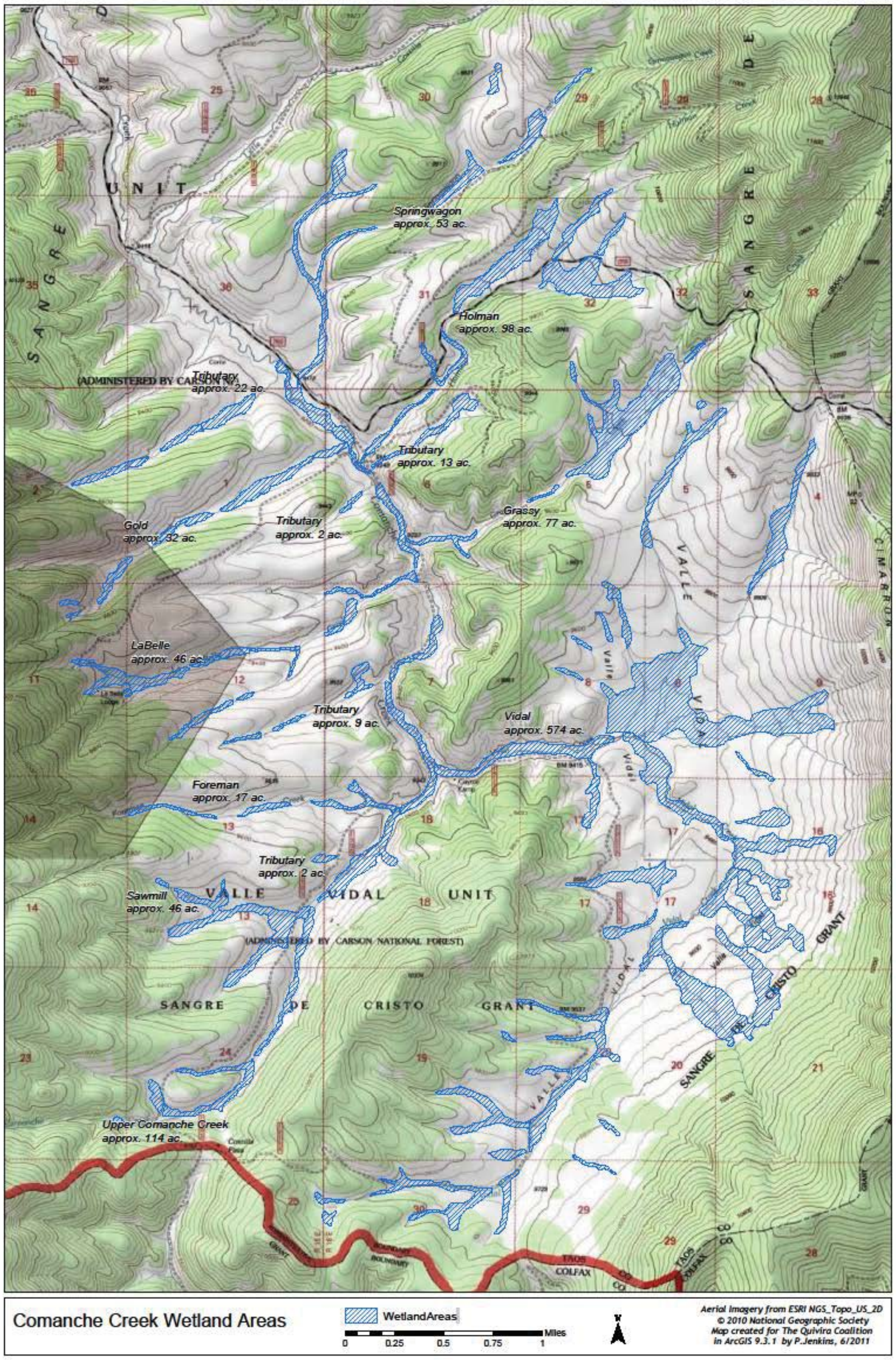


Figure 3. Map of Comanche Creek Wetlands. Blue shading indicates wetlands acreage in the Comanche Creek Wetlands Watershed. Carson National Forest, Valle Vidal Unit. Quivira Coalition, 2011.

1.7 SPECIAL TRAINING/CERTIFICATION

SWQB personnel involved in data collection and monitoring are bound to the same training requirements that are indicated in the SWQB QAPP (SWQB, 2016). Data collection and monitoring will be primarily carried out by Emile Sawyer, Project Officer, and SWQB staff. All SWQB staff that may collect data for this project have training or will be trained to collect data. If contractors are needed to fulfil data collection requirements, at any point during the project, to insure completeness, the following requirements will be adhered to:

Any contractor/subcontractor performing vegetation monitoring will be required to have the minimum of a bachelor's degree related to biology, botany, or conservation. The contractors and subcontractors must have experience collecting vegetation data using the techniques listed in this QAPP.

Any contractor/subcontractor performing geomorphologic monitoring needs to have demonstrated survey skills and a background in fluvial geomorphology, which could include university coursework, experience/training in riparian/wetland/stream ecology, familiarity with channel evolution concepts and models, or a successful project design and implementation track record in which determining the natural potential of a site was documented with professionally accepted methodologies.

Contractor qualifications will be documented through resume and professional references. The qualifications will be reviewed by the SWQB Project Officer for this project. The documentation of this information will be kept in the SWQB project files managed by the File Manager. The qualifications listed in the following experience summaries for project personnel below are to be used as a guide, if other personnel are needed to complete the project.

Emile Sawyer, M.S. Hydrogeology, is the Project Officer for the effort and is responsible for data collection and monitoring. He is an Environmental Scientist-Specialist and Wetlands Program team member for NMED, based in the Santa Fe Office. Prior to attending New Mexico Highlands University, where he earned his Environmental Science - Geology degree in 2003, Mr. Sawyer worked from 1992 to 2003 as a contract forestry technician, collecting biological and forestry related data throughout the Rocky Mountains. He earned his M.S. in Hydrogeology from the University of Nevada - Reno in 2009. Mr. Sawyer’s graduate research at the Desert Research Institute in Reno, Nevada required water quality and invertebrate species sample collection in the Great Basin; and used stable isotopes to track groundwater flow and evaluate a water balance model in the Colorado Flow System of eastern Nevada. Mr. Sawyer has been trained in Natural Channel Design, wetlands plant identification, and water quality sampling. He is currently overseeing Mapping and Classification, Rapid Assessment Methods development, and wetlands restoration projects for SWQB.

Mollie Walton, PhD Biology, Restoration Ecologist, will serve as coordinator for this project with Jan-Willem Jansens. Dr. Walton has more than 25 years of experience managing restoration projects in the southwestern United States and has undertaken innovative wetland and riparian restoration projects in New Mexico since 2006, including water related restoration projects from construction of water harvesting structures in the Chihuahuan Desert to restoration of wetland habitats in the Rio Grande bosque. She has completed training for Climate Change Vulnerability Assessment and is an expert in monitoring techniques for restoration projects from desert systems to the headwater slope wetlands of the Southern Rocky Mountains.

Jan-Willem Jansens, MS Agricultural Science, Landscape Architecture, Landscape Planner, will serve as coordinator with Mollie Walton. Jansens is the owner of Ecotone Landscape Planning, LLC. Jansens has more than 30 years of experience in landscape planning and ecological restoration, including 24 years of work in the southwestern United States, and more than 12 years of work experience developing and managing innovative riparian area and wetland planning and restoration projects in northern New Mexico. Between 2014 and the present he has led several bosque wetland restoration and aquatic habitat restoration projects along diverse reaches of the Galisteo Creek. Between 2011 and 2014, he also managed several Natural Channel Design projects for a RERI project in the Embudo watershed. In addition to project management, he was involved in site assessments, conceptual design, permitting, evaluation of final design, subcontractor coordination, implementation oversight, and monitoring. He has also designed and implemented three small Keyline design experiments in mesic piñon-juniper woodland sites around Santa Fe.

Alan Klatt, M.S. Watershed Management, will provide technical support for data collection and monitoring. He is an Environmental Scientist-Specialist for NMED and a member of the Implementation and Restoration Team based in Santa Fe. Alan earned a Bachelor of Science degree in Environmental Management from California Polytechnic State University in 2011 and a Master of Science degree in Watershed Management from the University of Wyoming in 2015 where he was responsible for operating and maintaining a network of gaging stations and meteorological stations within an experimental watershed. Alan began working for NMED in 2016 and has received training under several of NMED's Standard Operating Procedures including Chemical Sampling, Nutrient Sampling, and Physical Habitat Measurements.

Karen Menetrey, B.A. Geological Sciences, is a Project officer for wetlands/river protection and restoration projects. Wetlands program development projects include: mapping and classification for the National Wetlands Inventory; beaver habitat assessment on federal lands; wetlands restoration at Sulphur Creek; slope wetlands restoration at Comanche Creek. Manage a state-funded river restoration program by: issuing requests for proposals, coordinating project selection with a multi-agency committee, negotiating work plans and contracts, participating in project planning, conducting contract compliance site inspections. Oversaw contracts for 53 river restoration projects throughout New Mexico totaling approximately $9.5 million from 2007-

2016. Project officer for two statewide watershed forums. Drafted and revised technical surface water quality planning documents. Ms. Menetrey has been trained in Natural Channel Design, wetlands plant identification, water quality sampling and greenline monitoring.

1.8 DOCUMENTATION AND RECORDS

Copies of this QAPP and any subsequent revisions will be provided to all individuals included on the distribution list by the SWQB Project Officer. The SWQB Project Officer will also distribute all applicable protocol documents and subsequent revisions used throughout the project to the appropriate contractors. The QAPP, protocol documents and monitoring reports will be maintained in the project file at the SWQB in Santa Fe, NM.

Data acquisition will be obtained and processed by the field team. Field team members include those listed above in section 1.7. Field team members will provide processed data to team reviewers who will be comprised of qualified SWQB staff that have not performed the specific data acquisition requiring review. Once data has been reviewed it will be returned to the project officer with a short review report that describes why data is acceptable or not and any questions the reviewer may have about the data.

Table 3 Reporting Format and Storage

Monitoring Technique	**Reporting Format**	**Storage Location And Time**
Identification of vegetation along with vegetation cross-section and greenline composition monitoring	Data recorded on project specific field sheets and spreadsheets. Reported in monitoring report attached to final report.	Paper copies in project file, electronic copies on CD and hard drive at SWQB and The Quivira Coalition.
Fluvial geomorphology measurements	Data recorded in any professionally accepted field note form and transferred to The Reference Reach Spreadsheet Version 4.1L (Mecklenburg, et al., 2004).	Paper copies in project file, electronic copies on CD and hard drive at SWQB and The Quivira Coalition
Hydrological properties.	Data recorded on project specific field sheets, spreadsheets and data recorders (i.e., Level TROLL ® 500).. Reported in monitoring	Paper copies in project file, electronic copies on CD and hard drive at SWQB and The Quivira Coalition

	report attached to final report.	
Photographic documentation (all aspects of project)	Data recorded in accordance with Appendix I, *Let the Water Do the Work* (Zeedyk, et al, 2009).	Paper copies in project file, electronic copies on CD and hard drive at SWQB and The Quivira Coalition.
Soils-character of the soils including hydric soil indicators.	Data recorded on project specific field sheets and spreadsheets. Reported in monitoring report attached to final report.	Paper copies in project file, electronic copies on CD and hard drive at SWQB and The Quivira Coalition

2.0 DATA GENERATION AND ACQUISITION

2.1 SAMPLING PROCESS DESIGN

Restoration Design Approach
A "natural function" approach to design seeks to identify a reference condition which consist of stable geomorphic dimensions of a channel, adjacent flood plain, and wetlands then incorporate those characteristics into designs to meet specific objectives. Using available reference conditions and conducting an assessment of pre-treatment project area conditions it is possible to closely match the characteristics of a naturally functioning system which results in a design plan. Monitoring Components will be used to determine the natural function design approach, which involves four distinct steps (all steps will be documented and submitted in both quarterly and final reports):

1. Characterize existing physical and biological parameters,
2. Identification and characterization of reference conditions,
3. Evaluation of existing conditions at pre-treatment sites against reference conditions identified, to determine:
4. Development of Keyline design techniques and design features to move the system towards the reference conditions.

The monitoring components to be employed are: 1) vegetation cross-section and greenline composition monitoring, 2) fluvial geomorphologic monitoring 3) hydrology monitoring, and 4) photographic documentation. Supplemental soils data may be collected if time and budget allow. Fluvial geomorphology monitoring, vegetation cross-section and greenline composition monitoring along with repeat photographic documentation will occur at pre- and post-treatment restoration implementation sites. Pre-treatment data will be conducted prior to implementation of the Keyline design techniques and installation of water redistribution structures. The monitoring components will be used to evaluate the effectiveness of the Keyline design techniques by documenting the change in rewetted wetland acres at pre-and post-treatment implementation sites.

The methods for data collection, and equipment are described for each monitoring component in section 2.2 Sampling Methods. Monitoring methods described in this plan are designed to be conducted for the duration of the grant (short-term).

2.2 SAMPLING METHODS

The monitoring components of the project, including vegetation monitoring, geomorphology, hydrology, and photographic documentation will be conducted at least pre and post design installation, and will employ the use of data collection methods. All methods used for this project are described below. At least two persons will perform field data collection activities at all times to insure safety and quality assurance.

1. Vegetation Monitoring

Vegetation cross-section and greenline composition monitoring will be collected at the same locations as fluvial geomorphology cross sections, pre and post project implementation. The Vegetation cross-section and greenline composition monitoring method will be performed using the protocol established in *Monitoring the Vegetation Resources in Riparian Areas* (Winward, 2000).

Beyond community composition protocol outlined in Windward, 2000 obligative and facultative wetland flora will also be documented to Genus and species. Two monitoring participants will be present during vegetation monitoring to verify vegetation Genus and species. If data are questionable, field staff will perform monitoring again at those locations with questionable data to confirm or deny original data collected. If a flowering plant cannot be identified in the field as to species and there are no reproductive structures for positive identification, the plant will be recorded as to Genus or to Family (if it is not possible to identify to Genus). If a species cannot be identified, a specimen in flower (if available) will be collected, pressed, and taken to an expert or herbarium for determination.

Equipment: tape measure, field sheets, vegetation field identification guides,

2. Fluvial Geomorphology

The geomorphologic surveying will includes cross-sections, and slope which will be surveyed at a minimum of five locations to assess wetland dimensions and profile. Data will be collected in the field and entered into specially created MS Excel worksheets for analysis of valley type, landscape position, longitudinal profile, and slope gradient.

The following procedures are used to survey cross-sections: The endpoints (2) for each cross section will be marked/monumented with rebar; using a 3-4' x 1/2" (or 5/8") rebar driven flush with native ground surface (or up to ½" above native ground surface). The rebar should be driven into each valley edge on each side of a wetland complex. The pins are placed vertical to ground surface. GPS waypoints/coordinates will be recorded for every endpoint rebar, plotted on a Digital Orthoimagery Quarter Quadrangle DOQQ, and visually verified for correctness. Use top of the left-side rebar as the benchmark. Beginning at the left pin (looking down valley) a tape is stretched between the pins as tight as possible. Sag in the tape can distort measurements significantly. Working from left to right (facing down valley) the distance on the tape (station) and the ground elevation is measured and recorded using a surveying device. At each survey base station location a pre-survey accuracy check for the leveling instrument will be documented (Harrelson, p.20, or according to manufacturer's recommendations). A minimum of five (5) measurements are taken at a maximum of one (1) meter apart and more closely together to record changes where obvious change in slope occurs. Fieldnote format should be according to recognized professional surveying standards (Harrelson, p.28, figure 35, left half). Any sketches such as on right side of figure 35 are welcome, but not required. Make field notes to show:

- -date, weather, survey party, Instrument make, model, and serial number.
- -left-side endpoint rebar as station 0.0 feet;
- -distances measured along the cross-section line in feet and tenths.
- -left-side top-of-rebar elevation as 100.00 feet.
- -rod readings to one-hundredth of a foot.
- -brief remarks for each shot sufficient to describe the upland/wetland morphology and vegetation.
- -an ending 'check benchmark' shot after measuring each cross section, whether or not more than one instrument setup was used because of turning points.

Submit a single Excel spreadsheet with X-Y pairs (distance-elevation) for each cross-section.

A longitudinal profile of the wetland complex will be taken at each cross section 300 feet both upstream and downstream of the cross section to determine slope.

Photograph each cross section from both up valley and down valley, and from each side of the wetland complex standing somewhere on the cross-section line itself, sufficient to show the valley area at the time of survey. If possible, take photographs with the measuring tape lying on the ground along the cross-section line.

Data: Station and elevation in feet will be collected to characterize valley cross-section and slope. Data will be stored on Excel spreadsheets.

Equipment: A leveling/survey device, survey rods, tapes, and a GPS unit will be used to collect cross-section and slope data.

3. Hydrologic Properties

Measuring groundwater levels will be done in accordance with the Wetlands Regulatory Assistance Program's Technical Notes ERDC TN-WRAP-00-02 *Installing Monitoring Wells/Piezometers in Wetlands* and ERDC TN-WRAP-05-2 *Technical Standard for Water-Table Monitoring of Potential Wetland Sites*. The purpose of this note is to help wetland scientists obtain quantitative information about shallow ground-water regimes near wetland boundaries and in adjacent uplands. Monitoring wells and piezometers are some of the easiest means of determining depth and movement of water tables within and immediately below the soil profile. Monitoring wells or piezometer will only be installed after Forest Service approval and clearance/permits from Office of the State Engineer. Groundwater level, pressure and temperature data will be measured, collected and stored using In-situ Level TROLL ® 500 Data Loggers. These devices will be calibrated in accordance with manufacturer's specifications and documented on the field sheets that will be included with the final monitoring reports. Field sheets will include the make, model, and data generated by equipment.

Water samples may be collected for deuterium and oxygen-18 stable isotopes from the piezometers, local springs and streams to evaluate water mixing and determine origin, such as snow melt, surface water, and which ocean body the precipitation traveled from. Methods will follow Timmons et al., 2013 protocols.

4. Photographic Documentation

Photo points will be set up at several sites within the project area to capture changes over time in the slope wetland areas. Photo point markers will be carefully located and monumented with rebar pins. Locations will be recorded with a GPS unit, plotted on scaled maps, and verified for accuracy. These photos will provide a broad view of the site. The photo-documentation protocol established in *"Let the Water Do The Work", Appendix I, Outline for Photographic Monitoring Plan* (Zeedyk, et al, 2009) will be used for this procedure.

Data: Annual photographs to show vigor of native re-vegetation efforts, increases in overbanking during flood events, and general site characteristics. Photos selectively placed at representative treated areas throughout the reach will track restoration efforts and vegetation establishment. The overall reach photos will show the response of the riparian corridor to the enhancement treatments. Photos of soils will document soils present and any hydric soil indicators.

Equipment: Digital camera, tripod, GPS unit, photo board, rebar pins

5. Soils

Methods for the description of soils published by NRCS and USACE (USACE 1987, NRCS 2006 and Schoeneburger et al, 2002) will serve as the guide for collection of soils data. All soil characterization data from boreholes will be documented in the field and recorded on project specific field sheets. A photograph of the material retrieved from the boreholes will also be taken. Borehole locations will be documented using a GPS unit within the manufactures range of accuracy and plotted on a scaled map. If soil moisture probes are obtained for the project, they will be installed at same locations of boreholes and in accordance with manufacture specifications. Data will be record on same field sheets as other soil data.

Equipment: Hand auger, shovels, Munsell soil color charts, camera, measuring tapes, GPS unit, soil moisture probes.

2.3 SAMPLE HANDLING AND CUSTODY

No physical samples will be obtained as part of the implementation of this project and therefore, no handling requirements are needed. All data collected are maintained in paper or electronic copies that are provided to the SWQB Project Officer and maintained in the project files at the Quivira Coalition.

2.4 ANALYTICAL METHODS

Stable isotope water samples (i.e., deuterium and oxygen-18) will be delivered to the New Mexico Institute of Mining and Technology, Department of Earth and Environmental Sciences Stable Isotope Laboratory. The water samples will be analyzed on a Picarro Cavity Ringdown Spectrometer (L1102-I Isotopic Water Liquid Sampler). Analytical uncertainties for δ^2H and $\delta^{18}O$ are typically less than 1 per mil (‰) and 0.1‰, respectively.

2.5 QUALITY CONTROL

Quality control (QC) activities are technical activities performed on a routine basis to quantify the variability that is inherent to any environmental data measurement activity. The purpose for conducting QC activities is to understand and incorporate the effects the variability may have in the decision making process. Additionally, the results obtained from the QC analysis, or data quality assessment, may identify areas where the variability can be reduced or eliminated in future data collection efforts, thereby improving the overall quality of the project being implemented.

Quality Control mechanisms are implemented as described under the Quality Objectives and Criteria for Measurement Data as well as the sampling methodologies identified under this QAPP. Additional Quality Control includes the professional expertise of the personnel working under this project.

2.6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

The equipment used to collect physical measurements include a survey device (e.g. laser level, auto level, theodolite, or total station depending on the contractor), global positioning system unit (GPS), camera, and, if time and funding are available, soil moisture probes. All field equipment will be inspected prior to each sampling trip. All instruments and equipment will be tested, inspected and maintained in accordance with the manufacturer's specifications as included in the associated instrument/equipment manual.

Maintenance logs are maintained for all SWQB instruments and equipment. Consultants will use their own equipment. Results of equipment inspections will be noted in the maintenance log and/or project file. Any deficiencies in equipment will be noted and reported immediately. If condition of equipment is in doubt, it will not be used. In the event of instrument failure the SWQB Project Officer will correct the problem, rejecting the resultant data or accepting the data with notations.

2.7 INSTRUMENT CALIBRATION AND FREQUENCY

Instrument calibration and frequency will be done in accordance with manufacturer's specifications and documented on the field sheets that will be included in the interim and final monitoring reports. Field sheets will include the make, model, and data generated by equipment.

2.8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

There are no supplies or consumables that could affect the quality of data related to this project.

2.9 DATA MANAGEMENT

Data obtained for this project are maintained in paper and electronic files by SWQB Project Officer. If data are not collected by SWQB staff, data will be delivered to SWQB Project Officer as soon as practical following the data collection event. All data are maintained in the project file, on CD, SWQB network storage and the hard drive of SWQB Project Officer in Santa Fe, NM. SWQB Project Officer will analyze data for the effectiveness of Keyline design on Holman Creek.

Contractors will provide summary quarterly reports to the SWQB Project Officer. Quarterly reports and final project report will be compiled by SWQB Project Officer and submitted to U.S. EPA.

3.0 ASSESSMENT/OVERSIGHT ELEMENTS

3.1 ASSESSMENT AND RESPONSE ACTIONS

The SWQB Project Officer provides project oversight by leading, assisting with and/or reviewing data collection efforts. The SWQB Project Officer will assess project progress to ensure the QAPP is being implemented, including periodic audits by the QAO, as needed. A review of the restoration project occurs on a quarterly basis. This quarterly report describes the progress of each task to the restoration project and justifies task tardiness if applicable. Any problems encountered during the course of this project will be immediately reported to the SWQB Project Officer who will consult with appropriate individual to determine appropriate action. Should the corrective action impact the project or data quality, the SWQB Project Officer will alert the Quality Assurance Officer. If it is discovered that monitoring methodologies must deviate from the approved QAPP, a revised QAPP must be approved before work can be continued. All problems will be documented for inclusion in the project file and final report.

3.2 REPORTS TO MANAGEMENT

Quarterly Reports are submitted to U.S. EPA and include progress of project implementation and any available data. Printouts, status reports, or special reports for SWQB or U.S. EPA will be prepared on request. A report detailing the findings will be provided in the form of a monitoring report and a final restoration project report. The SWQB Project Officer will be responsible for the final project report to EPA. The vegetation monitoring consultant will prepare the vegetation monitoring report for approval by the SWQB Project Officer. The final report will be prepared in accordance with *Informal Draft Final Report Guidance* (Attachment E 2.0).

4.0 DATA VALIDATION AND USABILITY

4.1 DATA REVIEW, VALIDATION, AND VERIFICATION

Data review and verification are key steps for ensuring the integrity, suitability and usability of the data. Data will be reviewed by the SWQB Project Officer prior to demobilization from the field site or no later than two (2) week after data collection. Data will be considered usable if the requirements of this QAPP were followed and the data is within acceptable range limits as defined under this QAPP. Data that appears incomplete or questionable for a parameter will be flagged for review. Flagged data will be discussed with the Project Officer to determine the potential cause and usability. If a reasonable justification for use of the data cannot be attained, those data will be not used in analysis and implementation of restoration activities unless the data can be recollected and assessed for usability.

4.2 VALIDATION AND VERIFICATION METHODS

The SWQB Project Officer will be responsible to ensure that valid and representative data are acquired. Verification of field sampling and analytical results will be performed by SWQB Project Officer. In the event gross errors or other questionable data are found, the Project Officer will consult with project personnel to determine the validity of the data. Results of the verification process will be included in the final reports

The verification for geomorphology monitoring may occur in the field or in spreadsheet form as tables and graphs and is based on best professional judgment and knowledge of the project area and methods used. The SWQB Project Officer will lead in collection of geomorphology monitoring data. If the data appears invalid, the SWQB Project Officer will consult with project participants to determine appropriate action.

Verification of vegetation cross-section and greenline composition, hydrologic properties, photographic documentation and soil data will be performed by a member of SWQB field team that did not participate in field data collection. Review of field data will occur within two weeks of field data collection. SWQB Project Officer will consult with all project personnel to verify data and determine whether or not questionable data can be used

Laboratory generated analytical data will be verified and validated according applicable sections of SWQB SOP 15.0 Data Verification and Validation. All applicable section of the Chemical Data Verification and Validation Worksheets (A1) will be used for verification and validation of laboratory generated data. Worksheets are available at https://www.env.nm.gov/surface-water-quality/sop/.

Results of the verification process will be included in quarterly and final reports.

4.3 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Once all data have been verified they will be reported and analyzed and incorporated in the final project report. The data collected from this project will be adequate to determine the efficacy of Keyline design to restore and increase the number of slope wetland acres in the Comanche Creek Watershed. The information obtained as part of the project will be useful to private citizens and resource managers looking for ways to successfully protect and restore slope wetlands in New Mexico.

5.0 REFERENCES

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6.0 APPENDICES

6.1 RECEIVING FORM

New Mexico Environment Department Surface Water Quality Bureau

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Keyline Design for Restoration of Headwater Slope Wetlands in the Holman Creek Wetlands Complex Watershed Quality Assurance Project Plan

Acknowledgement Statement

This is to acknowledge that I have received a copy (in hard copy or electronic format) of the Keyline Design for Restoration of Headwater Slope Wetlands in the Holman Creek Wetlands Complex *Quality Assurance Project Plan*.

As indicated by my signature below, I understand and acknowledge that it is my responsibility to read, understand, become familiar with and comply with the information provided in the document to the best of my ability.

____
Signature

____
Name (Please Print)

____
Date

Return to SWQB Project Officer (Emile Sawyer)

6.2 INFORMAL FINAL MONITORING REPORT GUIDANCE

Informal Draft Final Report Guidance 3/11/1999

1. Executive Summary (general overview about the project)

• Title
• Define NPS problem(s) being addressed
• WQ goals and objectives
• Original timeframe
• Cooperators involved
• Funding (Fed and State)
• Possible BMPs to implement ·
Source of information: Workplan cover sheet, and any associated amendments

2. Project Chronology

• Describe major project highlights
• Monitoring DQOs (if applicable)
• BMPs implemented and why
• Obstacles
• Measures of Success (give estimates of how much NPS Pollution was achieved)
Source of information: Workplan, QAPP (if applicable), Quarterly/Semi-annual Reports and any associated amendments

3. Lessons Learned

• What made the project successful?
• What made the project not so successful?
• What would you do differently in terms of effectiveness?

4. Technical Transfer

• What information can you pass along to other agencies, cooperators or local landowners in other watersheds about this project.
• What other projects that are currently in progress or on the drawing board could benefit from this information?

5. EPA Feedback Loop

• What would you suggest EPA do differently to improve the NPS process in regard to this project?

- What about other Federal partner(s) if any?